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Surficial Materials of the Wildlands of Northwestern Maine

INTRODUCTION

During the summer of 1974 the surficial geology of northwestern Maine was mapped on a reconnaissance basis. The mapping was sponsored by the Land-Use Regulation Commission and the results are designed to be part of the basis for zoning the land use in the unorganized townships in the area of study. The following areas covered by United States Geologic Survey quadrangles were mapped in whole: Rangeley, Oquossoc, Cupsuptic, Kennebago Lake, Stratton and Phillips Quadrangles. Nearly all the Old Speck Quadrangle was mapped. Those portions of the Milan, Errol, Second Lake, Moose Bog and Arnold Pond Quadrangles that lie in the State of Maine were mapped.

The area of study is bounded on the north by the border between Canada and the United States, on the west by the Maine-New Hampshire border, and on the south roughly by the Longfellow Mountains. No particular border exists along the easterly extent of the mapping.

The quadrangles used as the base of mapping are at a scale of about 1 inch to the mile, a scale appropriate for reconnaissance study.

The total area within the area studied is about

1,100,000 acres, or about 5% of the area of the State of Maine.

Previous Work in the Area

Stone (1899) studied the glacial deposits of much of the State of Maine but did not visit the area of the present study (p. 187) and reached only Lower and part of Upper Richardson Lake (p. 216). Stone, however, did deduce (p. 189) that few sand and gravel deposits exist in northwestern Maine. Leavitt and Perkins (1935) also mapped the major glacial deposits but paid scant attention to northwestern Maine except in the area of Eustis, Stratton and Kingfield. Borns and Calkin (1970) studied the glacial deposits of the Stratton-Bigelow region, and their conclusions were confirmed during the mapping reported here.

Recent studies of the bedrock geology of northwestern Maine are those of Moench (1971) and Harwood (1973) and Green and Guidotti (1968).

Access and Exposures

Several state roads provide limited access to the study area, particularly in the southern part. Further access is available from the roadbeds of abandoned narrow-gauge railroads, many miles of which have been maintained as excellent roadways. Numerous logging roads extend in a good network into even the remotest parts of the area. Finally, the several large lakes forming the headwaters of the Androscoggin not only allow easy access to areas not served by roads or foot trails, but also provide along their many miles of shore some of the best exposures of the glacial deposits.

Other natural exposures exist in stream banks and valleys. Road cuts and borrow- and gravel-pits exist in all parts of the area.

GLACIAL GEOLOGY OF NORTHWESTERN MAINE

Effects of Erosion

The most obvious effect of glacial erosion is the large-scale deepening of the major north-south-trending valleys. The valleys of Aziscohos and Richardson Lakes, which were major pre-glacial stream-eroded meandering valleys and were overdeepened by glacial erosion, are excellent examples of these. These and other large lake basins in the area are mostly the result of ice erosion. Glacial striations and grooves near lake shores are roughly parallel with the orientation of lake valleys in the vicinity of the striations. Based on the lake depth measurements on available fishermen's maps, the lakes have been eroded as much as 50 feet below their natural outlets.

Striation directions measured at elevations above lake valleys indicate a general N10° to 20°W orientation, which is consistent with ice-movement direction indicators in other parts of west and west-central Maine.

Erosion of valley walls above lake levels has produced steep, nearly vertical rock slopes, as, for example, occur on the southwest slope of Observatory Mountain in the Oquossoc Quadrangle and in Black Brook, Sawyer and Grafton Notches in the Old Speck Mtn. Quadrangle.

On Crocker Mountain, Stratton Quadrangle, and Old Speck Mountain and other nearby mountains in the Old Speck Mtn. Quadrangle, several prominent cirques occur. Cirques are formed at the head-of-valleys occupied by local valley glaciers. On Mt. Katahdin valley glaciers were active during or following the waning stages of the last (Wisconsin) ice sheet (Caldwell, 1972). Borns and Calkin (1970) find no evidence that the cirques on Crocker Mountain had active valley glaciers during or after the dissipation of the last ice sheet.

Deposits of Active Ice

The most widespread glacial deposit in the study area is till or hard-pan. In numerous exposures the till is compact, slightly fissile and clay-rich. Such till is interpreted as lodgement or basal till, plastered on the land surface by active ice. Overlying the basal till in several exposures is a loose, sandy till interpreted as material let down directly from melting ice, without being reworked by meltwater. Such material is termed ablation till. On most mountain- and hill-tops and upper slopes the till is thin ablation till, with numerous exposures of bare bedrock.

In a few valley exposures till underlies glacial gravels and sand and likely does in other areas, where gravel and sand form the surface materials. In some lowland exposures both ablation and lodgement till form the surface material. Lowland till deposits likely represent the maximum thickness that the till reaches, as, for example, occurs in the headwaters of the South Branch of the Dead River in the Kennebago Lake Quadrangle, in Dallas Township. Here Borns and Calkin (1970) describe a complex section of till and interlayered gravel and sand at least 50 feet thick. The significance of this deposit is described in a following section dealing with the age of the glacial deposits in the area. Likely some other till deposits are as thick or thicker than the Dallas Township exposure. The type of till that occurs in a particular area will determine, to some extent, the kind of land use possible in that area. This matter is also discussed in a following section dealing with the land-use potential of different glacial deposits.

Landforms Composed of Till

In most of the area of study the deposits of till have no particular topographic expression but rather reflect the subsurface, pre-glacial bedrock topography. Only in the northern part of the Old Speck Mtn. Quadrangle and in the adjacent northeast part of the Milan Quadrangle has any significant constructional till topography been formed.

East and southeast of Lake Umbagog, mostly in Upton and C Surplus, there are 10 or more large drumlins, oriented about N50W. These were the only drumlins seen in the whole area of study. Drumlins are streamlined hills of compact till believed to form near the margins of ice sheets and their formation and orientation are presumably the result of ice movement during the waning stages, rather than advancing stages, of glaciation.(Koteff, 1974; Muller, 1974). Indeed drumlins often occur in clusters within a few miles of and in the up-ice direction from recessional moraines (Koteff, 1974). It is interesting to note that just to the east of C Pond in C Surplus (Old Speck Mtn. Quadrangle) is the only distinct moraine in the area. This moraine (here named the C Pond moraine) apparently records the last position of active glacial ice in northwestern Maine.

C Pond moraine is a hummocky deposit of loose till with numerous large boulders on its surface, which rises some 50 feet above the surface of C Pond and slopes eastward toward Sawyer Notch. Against the northern valley wall a prominent spillway 20 or more feet deep cuts into the moraine and slopes eastward. Apparently an active tongue of ice flowed into the valley of C Pond from the west and deposited the moraine at the eastern terminus of the ice. Meltwater from the melting glacier drained across the moraine in the spillway.

This interpretation of the deposit indicates a very different mode of deglaciation than is thought to have occurred in most of the rest of the area of study to the north and the east of C Pond. North of the Boundary Mountains, however, in southeastern Quebec, Shilts (1970) and others have found similar, though more widespread and larger, features that record active-ice deposition of moraines. The style of deglaciation thought to have occurred in most other areas in northwestern Maine is discussed in the following section, as is one other example of active ice front deglaciation.

Mode of Deglaciation in Northwestern Maine

Active ice-front deposits:

The formation of the C Pond moraine and its associated drumlins is discussed above. In Phillips, Madrid and Salem in the Phillips Quadrangle is other, though different, evidence of active-ice deglaciation deposits. On the south bank of Orbeton Stream, about one-half mile downstream from the settlement of Riley, about 50 feet of till is exposed. Overlying the till is about 50 feet of coarse cobble gravel with recognizable ice-contact slopes typical of head-of-outwash deposits. These gravels slope southeastward near the State Fish Hatchery, becoming finer-grained until, about 3½ miles from their origin, fine sand and varved silts occur. Most of the coarser deposits contain kettles. On the southwest edge of the deposit a large spillway formed between the deposit and a till hill. Large potholes and scour marks on the bedrock exposure near the Hatchery indicate large quantities of meltwater flowed through this spillway.

The sediments described above are similar to deposits in southern New England described by Koteff (1974). Koteff has named such deposits morphological sequences. Koteff's sequences begin at the head of outwash, adjacent to active, melting ice. Material brought to the ice front by ice motion is carried away from the ice front by meltwater. The larger-sized material is deposited near the ice front (the coarse gravels near Orbeton Stream). Finer gravel and sand are deposited in streams beyond the coarse material, and fine sand and silt, often deposited in temporary lakes, represent the end of the morphological sequence.

The significance of a sequence is that the head-of-outwash marks the position of an active ice front and, therefore, marks the still-stand of a glacier in the same way that recessional moraines do, as at C Pond.

North of C Pond and the morphological sequence at Riley, mountains rise steeply and form a 1000 to 3000 foot barrier between the lowland to the south and the generally low area between these mountains and the Boundary Mountains along the Canadian-United States border some 60 miles to the north. In this basin between the barrier on the south formed by Sugarloaf, Mt. Abraham, Saddleback and other mountains which trend southwestward from them and the Boundary Mountains to the north, lies most of the area studied during this project. The very different mode of deglaciation occurring here is described in the following section.

Deposits of glacial stagnation in the Rangeley Lakes-Stratton region:

In the basin between the Longfellow Mountains on the south and the Boundary Mountains on the north, there is no evidence of active ice front retreat. No recessional moraines exist in the basin and there are no identifiable morphological sequences. In addition, only a very modest volume of sand, gravel and other meltwater deposits occurs in this basin, especially in comparison with the volume of such deposits in the Madrid-Phillips area. Borns and Calkin (1970) conclude that the ice sheet thinned to such an extent that the high mountains in both the Longfellow and Boundary Ranges protruded through the ice surface as nunataks. Cut off from its source area north of the Boundary Mountains, the ice remaining in the Rangeley Lakes-Stratton basin became stagnant. The remaining ice in the basin dissipated only by thinning. The only rock material available for meltwater deposition was in the ice block within the basin and no other material could be carried into the area by ice movement. The effect of this style of deglaciation is the formation of small volumes of glacial meltwater deposits. Small, thin deposits of sand, gravel and other meltwater materials characterize most of the area of study.

Nearly all the sand and gravel in the Rangeley-Stratton basin is confined to or close to valleys. Valleys without lakes, such as the valleys of Kennebago River, Cupsuptic River and Megalloway River (Cupsuptic Quadrangle), contain discontinuous, small- to moderate-sized deposits of sand, gravel and minor deposits of silt. In valleys occupied by lakes, deposits of sand, minor gravel and interbedded silt occur along parts of the shoreline and at the northerly and southerly ends of the lakes. Without doubt the lakes cover larger volumes of meltwater deposits. As an example, the map of glacial deposits of Maine (Perkins, ?), published as a supplement to Leavitt and Perkins (1934), indicates a deposit of meltwater material extendeded over most of the area now covered by Flagstaff Lake. Presently only a few scattered deposits of gravel and sand occur along part of the shore, with a larger volume of fine sand in the vicinity of Stratton and Eustis. There is no available evidence concerning the extent and type of possible meltwater deposits under other large lakes in the region.

Detailed descriptions of the meltwater deposits occur in a following section of this report dealing with the glacial deposits of each quadrangle investigated. In another following section the very important effect that the limited sand and gravel deposits in the lake region have upon possible land use is discussed.

Age of Glacial Deposits in Northwestern Maine

In this area Borns and Calkin (1970) find evidence of two lodgement tills separated by lake and stream deposits. They believe this occurrence represents two stages of glaciation, separated by a non-glacial interval. These authors feel they can assign no definite age to either deposit of till.

Caldwell (1959, 1960) finds a two-till sequence separated by non-glacial sediments in New Sharon, Maine, about 40 miles southeast of Rangeley. Radiocarbon-dating of wood in the non-glacial sediments gives ages of greater than 42,000 and 52,000 years. It is not known if the New Sharon till correlates with the deposits in the Rangeley-Stratton area described by Borns and Calkin.

There is more evidence of the timing of dissipation of the Wisconsin ice sheet than of its advance. Borns (1974) finds evidence of end moraines in coastal eastern Maine that record the presence of the Wisconsin ice margin at some time between 13,500 and 12,300 years B.P. By 12,800 years ago the ice in the Rangeley-Stratton area had separated from the still active receding ice north of the Boundary Mountains (Borns and Calkin, 1970). The remaining stagnant ice in the basin had melted by about 12,000 years ago.

Since the dissipation of the last ice in the area, streams and mass-wasting have eroded parts of the glacial deposits and likely changed the glacial topography to some extent. Lakes formed in overdeepened basins have drowned other deposits. In the rest of the area, the land is little changed from the time the ice disappeared 12,000 years ago.

LAND USE IN NORTHWESTERN MAINE

Insofar as land use is determined by the type and extent of soil conditions, the glacial deposits in the area of study will determine the land use. Water supply, waste disposal, excavation and slope stability are determined by subsurface soil conditions which are, in general, related to the type of glacial deposits present.

Nature and Suitability of Surface Materials

The unconsolidated surface materials, or soil, of northwestern Maine consist of gravel, sand, clay, silt, till, and organic soils and muck. The nature of surface materials, either directly or indirectly, may limit several kinds of land use. The percolation rate of septic system effluent, the engineering properties, and suitability for construction are all determined by the characteristics of the surface material. The nature of this material, along with land slope and groundwater conditions, also affects the agricultural characteristics of the land. The nature, thickness, and lateral extent of unconsolidated surface materials determine the availability of well water supplies.

The upland soils are mostly till (hard-pan), a glacial deposit which is composed of a wide range of particle sizes, from boulders to silt and clay. Ablation till deposits are sandy and very stony and have a loose consistency. Lodgement till is very compact, with high percentages of fine particles in the silt-clay range. Loose, sandy till may have the percolation rates and ease of excavation which are found in some gravel deposits. Lodgement till, with an abundance of fine-grained particles, has poor percolation rates, modest water supply potential, and is excavated with difficulty. Lodgement till may underlie a few feet of ablation till. The land-use characteristics of most upland areas in northwestern Maine will be affected by the type of till present, which must be determined by on-site investigation.

Deposits of sand and gravel have relatively uniform grain sizes and have characteristics such as percolation rates which vary within a rather narrow range. Water supply potential and liquid waste disposal are generally good in such deposits.

Development Potential of Glacial Materials

The largest proportion of the land area in northwestern Maine is underlain by till or bedrock with thin or no till cover. Only limited parts of this area is suitable for intensive development unless outside water supply and liquid waste disposal are available. An exception to this generalization occurs in areas underlain by sandy, permeable ablation till. Because the present reconnaissance study did not differentiate between deposits of lodgement and ablation till, careful on-site investigation of soil conditions in till-covered areas may reveal development potential not shown by surveys of this magnitude.

Sand and gravel deposits suitable for water supply and wastewater disposal are very limited in most of the area, especially in comparison with the extensive meltwater deposits of the Phillips and Madrid areas.

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QUADRANGLE DESCRIPTIONS

The order in which the quadrangles are described is in the chronological order of the completion of our mapping of them.

In the following descriptions certain deposits, features or areas of note are located with reference to the nine sections into which each quadrangle is divided by 5-minute latitude and longitude lines. The accompanying sketch shows the location and designation of each of the nine sections.

NW	N	NE
W	C	E
SW	S	SE

Note: C stands for Central

Rangeley Quadrangle

Rangeley Lake and Saddleback Mountain are the dominant features of this quadrangle. The southeast end of Mooselookmeguntic Lake and numerous ponds, the larger of which are

Long Pond and Saddleback Lake, also lie in the quadrangle.

Nearly all the shore property of the lakes consists of till or bedrock thinly covered with till. Small deposits of sand and gravel occur on the south shore of Mooselookmeguntic Lake (W) and Saddleback Lake (NE). The largest deposit of gravel and sand in the quadrangle occurs in the headwaters of the South Branch of the Dead River in Dallas Plantation (NE). Small sand and gravel deposits are found in other stream valleys, as in the Bog Stream valley (W).

In lands higher than lakes and stream valleys, the most abundant deposit is till. Recently dug excavations for houses and roads reveal that tight, clay-rich till occurs in many of the higher elevations. In Dallas Plantation (N), the septic effluent from a motel does not percolate into this till, but saturates the soil right to the land surface. Only where uplands are underlain by ablation till can intensive developments have satisfactory liquid waste disposal systems.

The land in the Rangeley Quadrangle higher than about 2100 to 2500 feet has numerous bedrock outcrops or thin, bouldery till overlying bedrock. Precipitous rock slopes and cliffs are common.

Public Lots

The information available to us does not identify any public lots within the quadrangle. An unlocated public lot occurs in D Township (SW).

Unique or Critical Features

An arctic or subarctic flora occurs above timberline on Saddleback Mountain (NE). Although such vegetation does occur on Sugarloaf Mountain and Mt. Katahdin, it is unique and very fragile.

On the southeast shore of Mooselookmeguntic Lake (SW) glacial sand and gravel deposits are undergoing rapid wave erosion. This appears to be a natural situation caused in part by the artificial level of the lake, held up by the dam at the outlet. Although no feasible measures can be taken to halt the erosion, it is felt that further development of that shore will accelerate the erosion. Thus, there is the ironic situation that the shore property in the Rangeley Quadrangle that could most successfully handle large volumes of waste-water disposal would likely be destroyed by erosion were intensive development to occur there.

Oquossoc Quadrangle

About 25 percent of the Oquossoc Quadrangle is occupied by lakes, the larger of which are Mooselookmeguntic Lake and the Richardson Lakes. Small portions of Rangeley Lake and Aziscohos Lake also occur in the Oquossoc Quadrangle. The levels of all these large lakes are controlled by dams constructed in about 1885 and, according to the operator of Middle Dam (SW), are owned by Union Water Power Company of Lewiston, Maine.

These dams raise the water level more than 20 feet above the natural outlets. The description by Hitchcock (1862, p. 327-329) indicates that prior to these dams there were two separate lakes in the Mooselookmeguntic basin: Cupsuptic Lake at the northern end (NE) and Mooselookmeguntic Lake in the southern part of the basin. The lower end of Cupsuptic Lake, which was "low and marshy," lay to the west of Bald Mountain in the area of Stony Batter Point (NE). In Sandy Cove (C), about one mile northeast of Upper Dam, an extensive shoal of sand, now in about 15 feet of water, may be the remnant of a beach of the formerly lower Lake Mooselookmeguntic. Upper and Lower Richardson Lakes also were separated into two lakes, then called Mollychunkemunk and Welokenbacook respectively (Hitchcock, 1862, p. 328).

The shore of the present Mooselookmeguntic and Cupsuptic Lakes is mostly boulder with numerous bedrock outcrops. The majority of the rest of the shore is composed of till. In the southeast end of the Lake (EC), deposits of sand and gravel line much of the shore and similar deposits occur on the southeast ends of Toothaker and Students Islands.

The valley of the Kennebago River (NE) contains numerous scattered deposits of sand and gravel. Outwash deposits of sand occur near the floodplain of the river. At the Route 16 crossing, clay-rich till is exposed in the river banks.

The shore of Richardson Lake has more continuous sand and gravel than any other lake in all of northwestern Maine. These deposits begin near Black Point (C) and continue along the east shore, with only a few breaks, to South Arm (S), where both shore and island deposits occur. Near Horsebeef Point (S), similar deposits occur on the west shore of the lake. The rest of the Richardson Lake shore is formed of till and boulders apparently washed from the till. No bedrock outcrops were seen in the lake.

The valley that extends northwestward from the north end of Richardson Lake to Aziscohos Lake (NW) contains abundant sand and gravel deposits. An esker containing coarse sand and gravel extends almost continuously from the south shore of Aziscohos to Richardson. This is flanked by outwash of finer sand, with some interbedded silt layers. The rest of the southeast shore of Aziscohos Lake is formed of outwash sand and silt. Abundant bedrock outcrops form the rest of the Aziscohos within the Oquossoc Quadrangle, along with smaller areas of till deposits.

Much of the area above the lake levels is underlain by till, with a few isolated deposits of sand and gravel (N). Exposed bedrock and thin boulder till over bedrock occurs in the higher elevations in the quadrangle.

Public Lots

Five public lots and portions of two others lie in the Oquossoc Quadrangle. Two lots are at the southern end of Aziscohos Lake (NW), one partly along the southeast shore and the other on the hill above Aziscohos Dam, the shore lot having numerous camps. Richardson Pond (NW) and Peppermint Pond (NC) are in a Public Lot. Sandy ablation till occurs in exposures in this lot.

There are two public lots on Richardson Lake (S), one crossing The Narrows, the other to the south in Township C.

These two are the most attractive public lots, in my opinion, in the whole area of study. Extensive sandy beaches occur on much of this shore and no kind of development was found. A gravel logging road (not shown on quadrangle map) lies within one hundred yards of the east shore.

Two other lots lie in till and rocky high lands in Township C (S) and Magalloway Township (SW).

Unique or Critical Features

The three large dams form an important historic link to past lumbering operations and log drives.

Two major meltwater spillways, with boulder-strewn channels, have important scientific and educational value. These exist on the west shore of Upper Richardson Lake (C) and between Rangeley and Mooselookmeguntic Lakes, just south of Bald Mountain (NE).

The most critical areas in the quadrangle are the shore areas formed of sand, gravel and silt in both Aziscohos and Richardson Lakes. Extensive slumping and wave erosion occurs along these shores, especially on shores exposed to long expanses of open water. The activity associated with camps on these shores, especially in the South Arm area of Lower Richardson (S) and the southeast end of Aziscohos, has accelerated the erosion rate. Various measures to halt the erosion, such as rip-rap, old doors, sheets of plywood and piles of logs and brush, not only appear to have no effect but add an unsightly aspect to these extraordinarily beautiful beaches. On Metallak

Island (C) in Upper Richardson Lake, the foundation of a camp has been undermined by wave erosion, causing the camp to pitch onto the beach. Several other camps on these lakes appear to be in imminent danger of being undermined.

Errol Quadrangle

The valley of the Magalloway River between Wilson's Mills (NE) and the New Hampshire border (E) has extensive outwash deposits of sand and silt and minor amounts of ice-contact gravel. The floodplain of the river has reworked the sand and silt.

The shores of Umbagog (SE) and Aziscohos (NE) Lakes are largely formed from bedrock outcrops with thin till cover, with some till shores. No sand or gravel was seen on the shores within the Errol Quadrangle.

The higher slopes are till-covered, with areas of abundant bedrock outcrops (E, SE).

Public Lots

Portions of two public lots are located in the Errol Quadrangle (NE,SE). Both are on hillslopes in wooded, rocky or till-covered terrain.

Cupsuptic Quadrangle

Cupsuptic Quadrangle has three south-flowing rivers, the Kennebago, the Cupsuptic and the Magalloway, all of which extend over nearly the complete north-south dimension of the map area. All three valleys have abundant, but discontinuous, outwash sand flanked by ice-contact gravel and sand. A large deposit of outwash sand occurs at the west end of Kennebago Lake (E). At the north end of Aziscohos Lake (W), there is an extensive delta of sand and gravel that has been eroded into isolated island and shore deposits. Most of the upper Cupsuptic valley is formed of till and bedrock (N).

The upland areas, which dominate the quadrangle area, are till with bedrock at the highest elevations. Exposed till is tight, clay-rich and poorly drained.

Public Lots

Four public lots and a portion of another exist in the map area. Two lots occur at the head of Cupsuptic Lake (S), near the Forest Service headquarters. Both contain small deposits of sand near the lake shore; the rest is underlain by till and bedrock.

Two lots are located on the Cupsuptic River (S, C), both including the river within their areas. The northern of the two has little sand and gravel, while the other has abundant deposits of these materials.

The public lot at the east end of Kennebago is almost entirely underlain by medium to coarse sand, representing the largest single deposit of granular material in the map area.

Unique or Critical Features

The long, deep bedrock gorge in the upper Cupsuptic River valley (C, N) is the unique and striking feature of the area. The gorge is accessible by a gravel logging road.

Erosion of sand and gravel shores on upper Aziscohos Lake (W) and to a lesser extent on Parmachenee Lake (W) is similar to that occurring on other large lakes in the area.

Second Lake Quadrangle

A major portion of Aziscohos Lake (SE) lies in this quadrangle. The complete shoreline of this lake has outcrops of bedrock or till deposits thinly covering bedrock. The valleys of Little Magalloway (E) and Magalloway (NE) Rivers are swampy, with outwash sand and gravel remnants and ice-contact gravel.

The higher elevations of the Second Lake Quadrangle are till with small areas of bedrock outcrop. Most exposures indicate the till is fine-grained and compact.

Moose Bog Quadrangle

There are about 20 square miles of land in the Moose Bog Quadrangle that lie in the State of Maine. Part of the headwaters of the Magalloway River lies here. The valley contains abundant ice-contact sand and gravel, with a large swampy area in the center of the valley. The high elevations are till with only a few bedrock outcrops.

Arnold Pond Quadrangle

This quadrangle contains about 60 square miles of land that lie in Maine. Part of the headwaters of the Magalloway River extends to the southwest part of the quadrangle and a few segments of esker gravel deposits lie in its valley.

The upper headwaters of the Kennebago River reach the southeast portion of the quadrangle. This valley contains abundant ice-contact and outwash gravel and sand. At the head of the Kennebago watershed, at Grants Pond and Big Island Pond (SE), low passes lead to a northward drainage into Arnold Pond in Coburn Gore (E). From Arnold Pond the drainage flows southeastward into Chain Lakes and the Dead River drainage. A large portion of the valley leading to Arnold Pond and also east and north of the Pond is filled with ice-contact gravel and sand. The deposits extend through open valleys into Canada. The volume of gravel and sand in this area, together with the extensive outwash in the Dead River valley, indicates that an active ice front existed here. Ice-contact gravel and sand were deposited against stagnant ice, and meltwater streams transported sand and silt down both the Kennebago valley and the Dead River valley.

The higher elevations in the quadrangle are till, with major rock outcrops along the Boundary Mountains (SE).

Kennebago Lake Quadrangle

The most abundant sand and gravel deposits lie in the valley of the South Branch of the Dead River and southeast of Kennebago Lake. A complex deglaciation history is recorded in these deposits. Meltwater drainage from an active ice front in the vicinity of Coburn Gore (Arnold Pond Quadrangle) flowed down the Kennebago River (Cupsuptic Quadrangle) into Kennebago Lake, leaving the large deposits of outwash sand (W).

Stagnant ice blocks at the southeast end of Kennebago Lake (SW) and the Dead River valley (S, E and SE) at first forced the meltwater to drain southward through Redington Pond (Phillips Quadrangle). At this time, ice-contact deposits, consisting mostly of esker sediments and kame terraces, were formed. At some later time, the meltwater found a lower drainage northeastward and deposited a large kame terrace in the vicinity of Kennebago School (E).

The Kennebago-South Branch drainage later flowed into a glacial lake whose level was as much as 400 feet higher than the present Flagstaff Lake (Borns and Calkin, 1970). Successive lower lake levels formed as lower spillways were opened. Outwash from the Kennebago drainage formed a series of deltas (S) which record these lake levels. The lake finally formed Glacial Lake Bigelow at about 40 feet above the present Flagstaff Lake. Outwash in the South Branch Dead River (SE, E) is graded to this lake level.

Some smaller deposits of sand and gravel, occurring in the northeast part of the quadrangle, are related to ice-contact and outwash deposition.

The higher elevations are underlain by till, and there are large swamps in many higher valleys. The highest elevations are underlain by bedrock and thinly till-covered bedrock.

Public Lots

One public lot (SW) and a portion of another (W) occur in the quadrangle, one at each end of Kennebago Lake. Both contain extensive sand and gravel deposits with about equal areas underlain by till.

Phillips Quadrangle

The Phillips Quadrangle marks the transition between the generally undeveloped and sparsely populated forest and mountain land of northwestern Maine and the farms and industrial communities of central Maine. The north part of the quadrangle is dominated by the east spur of Saddleback Mountain (NW) and Mount Abraham (NE). The beginning of the rich alluvial valley of the Sandy River (S, SE) and numerous upland farms characterize the southern part of the quadrangle.

The character of the glacial deposits in the Phillips Quadrangle is also transitional. In the northern part of the quadrangle, upland till and rocky mountain slopes characterize the record of glaciation. Abundant ice-contact sand and gravel and outwash deposits occur in the southern part.

In the valley of Orbeton Stream, near Reeds (C), the beginning of a morphological sequence of glacial deposits marks the position of an active ice front. Ice-contact gravel grades southeastward into finer sands and silt. A larger outwash sand deposit occurs in Salem (E, NE). This material was carried by meltwater that flowed through a major spillway in which the roadbed of a narrow-gauge railroad was laid (E). Through this spillway, as well as from the ice in the Phillips-Madrid area, sand, silt and clay were carried into the Sandy River valley to the south where it formed extensive lake deposits as far as New Sharon (Caldwell, 1959).

Further up the Orbeton Stream valley ice-contact deposits occur in the vicinity of East Madrid (C). Higher up on the southwest slopes of Mt. Abraham, there are small isolated deposits of gravel (N) that apparently were formed from streams flowing between the emerging nunatak and the thinning glacier.

In the Redington Pond area (NW) are ice-contact and outwash deposits that represent a continuation of the drainage from the Kennebago Lake area to the northwest.

The highland areas are till-covered, with numerous bedrock outcrops and thinly covered bedrock.

Public Lots

Three public lots are located on the slopes of Mt. Abraham (N, NE). All three are in till-covered areas with steep slopes. The lot in the Rapid Stream valley (NE) has a small area of ice-contact gravel.

Unique or Critical Features

A deposit of well-cemented, till-like material is exposed about one mile west of the village of Madrid on the north bank of the Sandy River (W). The most abundant rock in this material is Madrid Formation, which contains abundant sulfide minerals. The weathering of the sulfides has produced the iron-oxide cement which holds this rock together.

An interesting relic of the logging industry is located on the steep south slope of Mt. Abraham, about two miles north of Salem.(NE). Here there are the decaying remains of a nearly mile-long sluice used to transport logs from the high mountain slopes to loading areas below. According to local residents the sluice, last used during World War II, was operated without water and the logs arriving at the bottom were almost free of bark.

Daggett's Rock, near Bean Brook on the south side of Tory Hill in Phillips (E), is said to be the largest glacial erratic in New England and estimated to weigh 8,000 tons (Lachance, 1974).

Old Speck Mtn. Quadrangle

In the valley of the Dead Cambridge River a large ice-contact and outwash deposit leads to a moraine at C Pond (N). Similar deposits occur in the valley leading from the south arm of Richardson Lake (NE). Other sand and gravel deposits are located in the Swift Cambridge River valley south to Grafton Notch (W) and in the headwaters of the West Branch of the Ellis River (C).

A series of drumlins occur in the vicinity of the Cambridge River valley (NW, N). Other uplands consist of till and bedrock outcrops. Nearly all of the southwest and central sections of the quadrangle are underlain by shallow or exposed bedrock.

A number of cirques lie at high elevations in the southwest portion of the quadrangle. There is no available evidence to indicate whether or not these cirques were all occupied by valley glaciers following the dissipation of the last ice sheet.

Unique or Critical Features

The moraine at C Pond is one of the few in northwestern Maine and is of great educational and scientific interest. The large pot holes at Screw Auger Falls, formed by glacial meltwater, are an important scenic feature of the area.

Milan Quadrangle

About 20 square miles of the quadrangle is in Maine. Most features are continuations of those in the Old Speck Mtn. Quadrangle. Two arms of Umbagog Lake (NW) lead to valleys with ice-contact and outwash sand and gravel deposits that continue in the valley of the Cambridge River. The shore of Tyler Cove has some of these deposits. Several drumlins occur near the village of Upton.

The southeast and eastern part of the area are largely thinly covered bedrock and numerous bedrock exposures.

Public Lots

A public lot lies in the mountainous, till-covered area adjacent to the New Hampshire border.

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